Superconducting Partnership with Industry: Readiness Review Update

Mike Gouge, ORNL
Steve Ashworth, LANL
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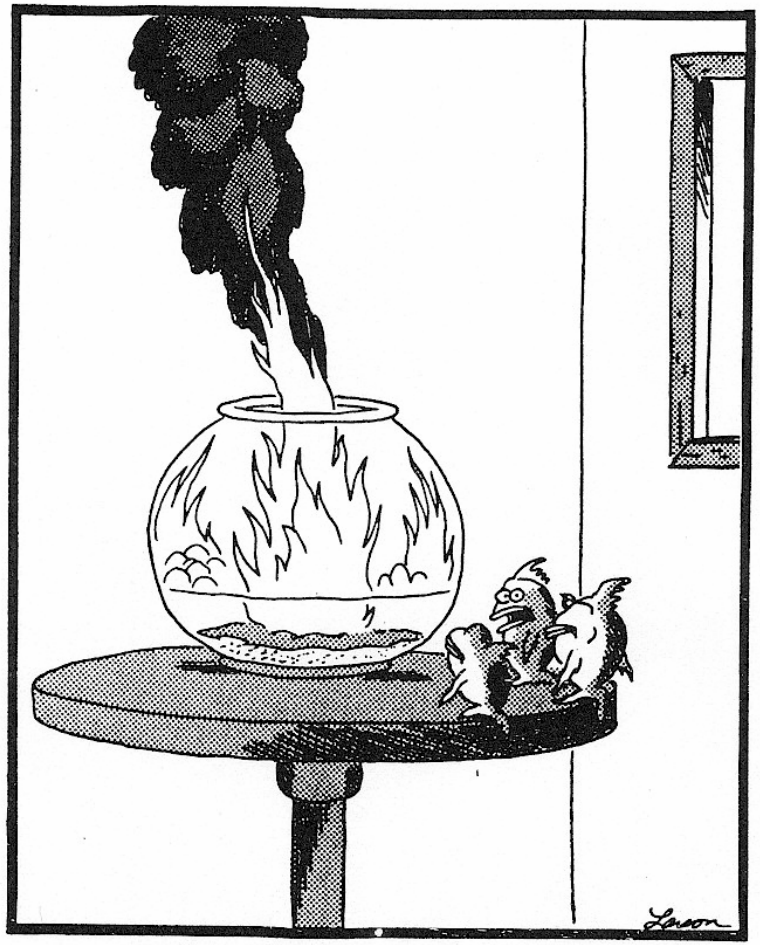
DOE 2006 Superconductivity Peer Review
July 25-27, 2006

SPI Readiness Review Program

- **Goal: enhance the probability of successful completion of SPI projects.**
- **The major tool: phased readiness assessments:**
  - **Focus is on early identification and resolution of technical issues**
    - issues involving cryogenic temperatures, vacuum + high voltage dielectrics remain a major concern
  - **Performed by a small group independent of the SPI team being reviewed.**
  - **Emphasis is on an objective technical review: in-depth but not an audit nor confrontational.**
  - **Report goes directly back to SPI team with a copy to DOE only.**



"Well, thank God we all made it out in time.
... 'Course, now we're equally screwed."

Budget: $210 K/year from DOE
$100 K - LANL (3 cable projects)
$110 K - ORNL (all other projects)

Anticipate at least 3 reviews over an SPI time cycle

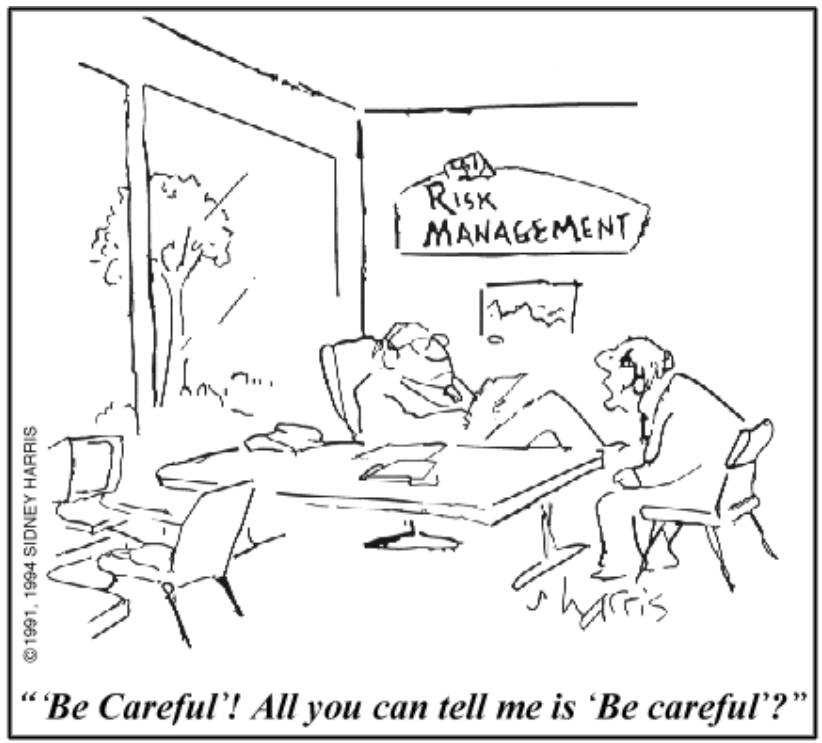
- **Phase 1**:
  - Shortly after the SPI award (typically during conceptual design), hold initial meeting to review the technical proposal and identify those system aspects with potential impact feasibility or reliability.
  - Identify resources and activities needed to address any potential problems.
    - Is the team organization/resources sufficient to address technical challenges?
    - Are incremental scaled-models and/or prototypes planned to reduce technical risks?
  - Meeting length – about 1 day.

Anticipate at least 3 reviews over an SPI time cycle

- **Phase 2**:
  - Prior to hardware procurement/fabrication (in the final design phase-FDR), review those critical areas where redundancy or back-up systems may be needed or where team prior experience may be limited.
  - Potential problem areas are vacuum system integrity, high voltage details, partial discharge, heat loads, unanticipated heating sources, thermal stresses, transient mechanical loads, etc.
  - Requires 1-2 days on-site with discussion of:
    - Risk assessment plans to prevent potential problems and
    - component/subsystem testing to qualify system prior to assembly.
  - Non-disclosure agreements are signed by reviewers if required.
  - Note several projects are reviewed at PDR stage also.

Anticipate at least 3 reviews over an SPI time cycle

- **Phase 3**:
  - Before system operation (for example, tie-in to the grid) do a final review to:
    - confirm that the prior review concerns have been resolved
    - inspect the as-built hardware.
    - At this stage safety systems (to protect personnel and hardware) could be reviewed in some detail.
  - Look over project test plans to ensure completeness (for example, generation of data for technical standards for new technology).



Peer Review Interface

- At the annual DOE peer review:
  - Each SPI team should present “readiness” preparation activities in accordance with the evaluation criteria.
  - Only non-proprietary information will be presented.
  - Peer reviewers provide feedback on readiness review program implementation by SPI projects.

Relevant 2006 evaluation criteria
distributed by Energetics

- **FY 2006 Performance/ FY 2007 Plans:** For SPI Projects – How is the team identifying/managing/mitigating risks to a successful demo?
- **FY 2006 Results**: Were major risks to a successful outcome identified and how were they mitigated? (via a focused R&D program and/or redundancy, for example)
  - SPI Panel: Included in this area are results and recommendations from the phased SPI readiness reviews by the independent review team chartered by DOE.
- **Research Integration**: Has the project team increased the likelihood of successfully accomplishing their goals by teaming with others?
  - Private sector presenters should describe how collaborations have accelerated their ability to overcome problems and mitigate risks in progressing towards commercial products and applications.
- **Bottom line**: **How well is the team addressing technical risk mitigation?**

FY 2003-2006 Results

- Four SPI readiness reviews in FY 2003
- Nine reviews in FY 2004
- Eleven reviews in FY 2005
- Three cable projects reviewed in FY 2006
  - The objective for 2006 was to continue focused reviews as projects complete assembly/installation and commission HTS systems into the electric grid.
- Readiness Review Teams provided valuable technical guidance to these SPI Projects.

2006 Results: Readiness Reviews

- A readiness review was conducted at General Electric Power Systems on September 27-28, 2005:
  - This was the project PDR and the scope included all generator systems impacted by the HTS rotor addition.
  - Reviewers were Mike Gouge from ORNL, William Hassenzahl-consultant from AEA, Charles Oberly from AFRL and Paul Bakke from DOE-Golden.
  - GE made a public announcement in January 2006 that they had reached an agreement with DOE to discontinue work on this 100 MVA generator SPI project
    - due to economic scaling issues with present superconducting tape and cryogenic technology.

- The MFCL project was in a reduced effort status since the last peer review due, in part, to reliability concerns with the bulk BSCCO tubes in the fault-limiting matrix.
  - Readiness reviews in 2004/2005 helped to identify project risk areas
  - Readiness reviews will resume when the SuperPower-led team establishes a new project technical baseline.

- Due to the above, the readiness reviews in 2006 focused on the three superconducting cable projects as they proceeded to assembly, commissioning and testing (Albany and Columbus/AEP cables) and prototype qualification and manufacturing (LIPA cable).
  - Review team led by Steve Ashworth (LANL) with Andreas Neuber (Texas Tech), George Mulholland (ACT), Ed Hahn (NYPA)

Cable Readiness Reviews

Steve Ashworth, LANL
Andreas Neuber, Texas Tech
George Mullholland, ACT
Ed Hahn, NYPA

Status of Cable Projects

- Albany and Columbus cables installed.
  - All reviews completed
- LIPA
  - Cable type tested and design finalized (May 06)
  - Cable now in manufacture
  - Termination type tested and design finalized (July 06)
  - Released for manufacture

Review Format

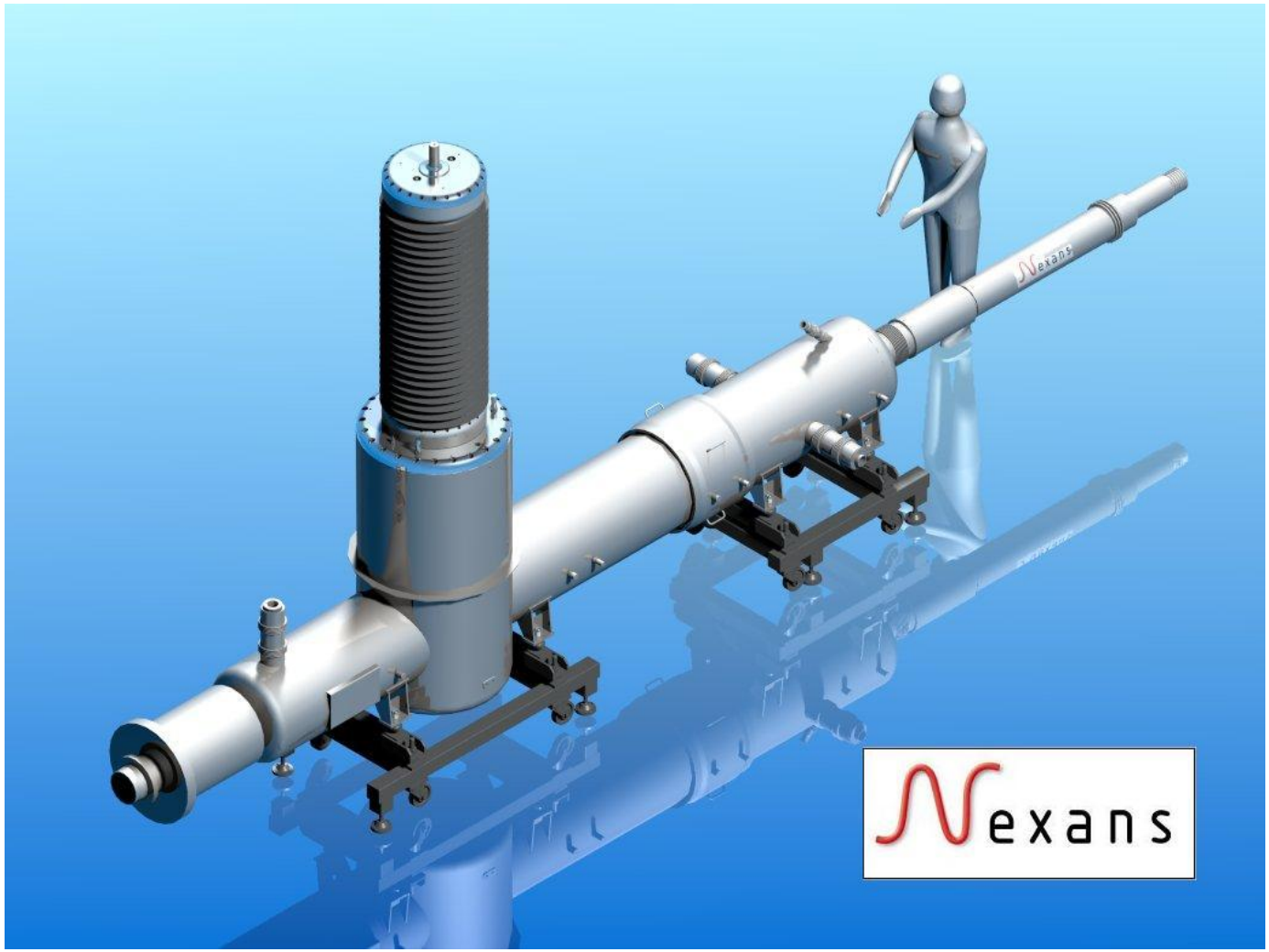
- Review Panel is *advisory*
  - All cable projects took review comments very seriously
- Originally intended as
  - Conceptual design stage (CDR)
  - Final design stage (FDR)
  - Pre-energization
- 'Live' master issue document
  - Held by project manager
  - Capture actions/issues/concerns from each meeting
  - Assign owner
  - Set 'solve by' date
- Reports from Review Panel

Reviews

- Albany and Columbus Cable Projects had this 3 review format (CDR, FDR, pre-energization)
- Areas of expertise covered in Panel:
  - High voltage
  - Cryogenics
  - Utility interface
- In 2006 expanded reviews for LIPA cable
  - Why?

Expanded Reviews: LIPA Cable

- Experience
  - 8 months behind other projects
  - Reviewers getting better at their job with experience
  - Recognize usefulness of more interaction
  - Comments from Peer Review panel after 2005
- Significantly more complicated
  - 138 kV
  - High fault current
  - Longer
  - Higher cost
  - Higher risk
- From review point of view: ‘2 projects’
  - Cable
  - Terminations
  - Each with own timetable, issues


Nexans

LIPA terminations with HTS cable

Biggest change: more frequent contact

- Suggestion from panel last year
- Updates (phone) every 2 – 4 weeks
- Present during cable ‘type’ testing
  - 1 week at test lab
  - Intent ***was not*** ‘audit’
  - Intent was more to provide extra input, different point of view
- Reports on various items arising
  - Lightning strike and cryostats
  - Cable shield currents
  - Cable sliding forces during cool down
  - Prototype tests (cable and terminations)
  - Type testing standards
- This expansion wasn’t ‘imposed’ on project team
- Team recognized value

Future SPI's and Reviews

- Personal opinion (S. Ashworth)
  - 'Review' is the wrong approach / word
  - Implies 'Veni, vidi, relinqui' ("I came, I saw, I left")*
  - DOE has largest financial stake in project (50%)
  - DOE technical representative (Review Chair) should be integrated in team
  - Formal reviews (full panel) increase to four times (from three)
    - More input earlier in project
    - Design changes at FDR impact schedule and cost
    - Issue has to be very significant to warrant changes at FDR stage
    - Review between CDR and FDR
  - Review Chair calls on specific expertise in Panel between reviews if anything arises (high voltage, cryogenics....)

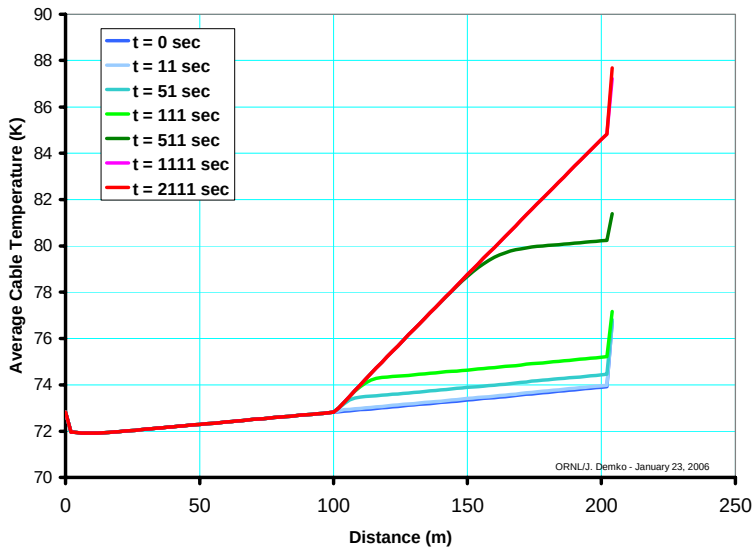
2006 Results: Cryogenic Dielectrics

- A workshop on cryogenic dielectrics was held on October 16, 2005 in conjunction with the IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP), October 16-19 in Nashville.
  - The workshop brought together experts in cryogenic dielectrics from the US, Europe and Asia.
  - There were 50 attendees with participation by SPI teams facing high voltage component qualification.
  - There were ten presentations followed by a panel discussion on future needs. The agenda included some overview talks on liquid nitrogen dielectrics, solid dielectrics, HV design practices, etc.

- There will be a 2006 Peer Review cryogenic dielectrics informal roundtable discussion on Thursday, July 27 at 1 pm.

2006 Results: Cable Generic Issues

- A recommendation from the 2005 SPI peer review was for the three cable project teams to look at generic technical issues.
- A generic cable issues session was organized on Feb 1, 2006 at the DOE Wire Development Workshop:
  - all three SPI cable teams participated.
  - real progress was made on understanding external (fault currents due to grid shorts) and internal (such as loss of vacuum in the cryostat) faults and their impact on the liquid nitrogen cooling system, especially pressure relief.
  - presentations were also made on cable cryostat reliability and lightning protection issues.
  - some areas needing more definition:
    - cable cryostat reliability for design life and commercial-scale lengths
    - is an arc-flash in liquid nitrogen a credible event?



- Loss of vacuum in second 100-meter cryostat section.
  - Have several minutes to detect and take cable off-line

FY 2006 Plans

- Continue focused reviews as projects complete final design, fabricate/install equipment and commission systems
- Encourage the SPI projects to develop risk identification and mitigation processes to manage risks. Review each project's risk mitigation plans in 2006
- More emphasis is needed on R&D and design guidelines in HV cryogenic dielectrics for the grid-based SPI projects.
- A web-site will be implemented with lessons-learned from prior SPI projects and general design guidance

FY 2006 Performance

- ✓ Readiness reviews in 2006 focused on the three HTS cable projects. A readiness review of the GE generator project was held at the PDR.
- ✓ All the projects have implemented risk assessment tools which are reviewed by the Readiness Review Teams.
- ✓ Conducted a High-Voltage Cryogenic Dielectrics Workshop as part of CEIDP. Cable generic issues session at DOE Wire Workshop. Cryogenics dielectrics R&D at ORNL (next talk). Roundtable discussion Thursday afternoon.
- o Delayed to FY 2007 due to resource constraints.

FY 2007 Plans

- **In 2007, readiness reviews will conclude on the three present superconducting cable projects as all three will be in the demonstration phase.**
  - **As was done for the 5/10 MVA HTS transformer project, lessons-learned readiness reviews will be done as these projects finish their planned demonstration periods in the next several years.**
- **A new program solicitation on superconducting power equipment is planned later in 2006.**
  - **In 2007 the selected projects will begin.**
  - **Shortly after this (typically during conceptual design), it is planned to hold an initial review of the proposed project's technical approach.**
  - **Also the team organization/resources will be reviewed to ensure sufficient capability to address technical challenges.**
- **In 2007 a web-site will be implemented that will have:**
  - lessons-learned from prior SPI projects
  - some general design guidance on high voltage, vacuum, etc. and
  - a place where SPI participants can post comments or questions and get feedback.

2007 Plans (continued)

- **Based on continuing issues with the performance of dielectric materials in HTS systems at cryogenic temperatures and at high voltage, more emphasis is needed on R&D and design guidelines in this area for the grid-based SPI projects.**

Research Integration

- **Since the reviews contain a large amount of proprietary material, the results and recommendations are typically shared only between the project being reviewed, the reviewers and DOE.**
- **The reviewers, to the extent possible, highlight or flag potential problem areas that they have learned from other project reviews.**
- **The cryogenic dielectrics workshop and cable generic issues session are ways to share approaches to common failure modes and lessons-learned.**
- **Have engaged review staff from 2 DOE labs, 2 DOD labs, a university, NYPA and outside consultants to leverage expertise.**